**Water Assist Pro**

**Microcontroller (Group E)**

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**Index terms**: Prototype, microcontroller, Sensors, motor, and wires.

**Abstract**: Technology is evolving every day. In the last few decades tech innovation has given rise to some products are now part of daily human life. Among one of the innovations are IoT devices that has made a new standard of safety and reliability. This paper aims to define a product of such class that we have created by implementing such sophisticated elements which included an Atmega128A microcontroller, Moisture and light sensors, a Dc motor, relay, and LED. We will briefly explain the system engineering and programming behind this whole project by defining each component and their functions. We have executed all these elements and made such device which will have a major impact in the consumer electronic sector. This device can detect moisture in a swimming pool and stop the flow of water automatically offering higher precision in reducing human effort and management. This will also detect day and night and give user a light ambience in their swimming pool to give a fancy look. This device will be replacing the traditional way of filling up a swimming pool manually and will make us go a step further in the world tech and innovation.

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1. **MOTIVATION**

Technology has changed our lives by increasing the speed of time. We were human. We invented and developed the technologies to change our lives to their best. Now that technology is changing our lives every second, IoT devices will create more reliability to control our everyday activities. While some IoT devices are easily identifiable and discernable to the human eye, others are very small and hidden from view. Many of these devices are embedded within other systems in the form of microelectronic components and systems. For example, a few leading companies are working on silicon chips that are optimized for emerging technologies such as IoT and artificial intelligence. As published in THE GUARDIAN, the IEA found that the world’s demand for electricity surged by 6% last year, following the global economic rebound from the 2020 pandemic recession, the steepest increase since 2010 when economies began to bounce back from the global financial crisis. The total increase in electricity demand was over 1,500 terawatt-hours, the largest on record.

**By using our efficient technological advance, we can make a difference in this sector of electricity crisis. Our team has worked hard to make such prototyping with advanced technical components which requires less human interaction and can do the most difficult job more precisely giving higher safety. This device can accurately detect water in a swimming pool and can also detect day and night using sensors and works according to user’s demand. Its accuracy has been tested in the lab and the efficiency it provides is being worthy.**

**Our intention to create such vehicle required a higher precision to develop it from scratch. Each component has studied thoroughly using UML diagrams and software techniques. Then it designed in 3D and laser cutting techniques were used for it. By using advanced programming using a microcontroller we have achieved the accuracy of the vehicle to get the job done. More renditions are required to work it in the real world, but in the next few stages we believe our prototype will make a difference in the consumer electronics sector.**

***Objectives***

***Goal:* To create an IoT device that can detect water and understand day and night.**

***Problem to be solved*: Being able to reduce electricity consumptions and human interactions using autonomous sensors.**

1. **REQUIREMENTS**

* The device needs to be autonomous and navigate by user specified demand.
* The system needs to provide a way for the user to interact.
* It should ecological and must recharge and the power source is non burnable
* It should be efficient to complete task and raise economical value to users.
* It should minimize errors by optimized code and power.
* The hardware should be well built for potential task, and it should have specified speed frequency.

1. **SKETCH OF APPROACH**

The initial approach of this project was having a clear idea of the microcontroller which we learned in the course. This includes the microcontroller itself and its related components and using UML diagrams for each section of the system. An appropriate organization of requirements diagram, activity diagram, block diagram, sequence diagram and state machine diagram made the system to be more understanding and preparing for the next following steps. Next, we also did an online simulation of the overall system by implementing the components in a microcontroller and the results were positive. Two diagrams are discussed briefly in the paper to have a clear overview of the device.

***3.1 Sequence Diagram***

A picture containing text, indoor

Description automatically generated

Figure 1: Sequence Diagram

A sequence diagram or system sequence diagram shows process interactions arranged in time sequence in the field of software engineering. It depicts the processes involved and the sequence of messages exchanged between the processes needed to carry out the functionality. In the following diagram, this activates the device from where the coordinates and location are uploaded from. In this case, Atmega128A from the device is paired with the device via ATMEL Debugger to PC and Jtech in the board. After the device is set, in the starting phase the water pump and light switch is off. When the device starts the dc motor(pump) is on until the moisture sensor detects water. It will function accordingly by turning on/off by 0 and 1. The light sensor gives a simple yet unique user experience when detects sunlight and dark environment. It will turn on the LED in the pool accordingly in day and night. User can also turn off the device manually via a push button when not needed.

**3.2** ***Block Diagram***

Diagram

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Figure 2: Block Diagram

A Block diagram is modular units of system that encapsulates its contents, which include attributes, operations, and constraints. Block diagrams are mostly used for definitions, and its parts are used for applications. Block diagram is used throughout all phases of system specification and design and can also be applied in different systems. It’s also used in collection of features to describe a system or other element of interest. In our system design, the Block diagram consist of mostly the 2 main parts which includes the water control and light control. The water control system includes the moisture sensor which works according to programable codes, and a push button function works as the water pump switch. Light control is explained to the light switch and the sensor which depicts dark and light environment to give the swimming pool a unique look.

1. ***Design And Programming***

This part is intended to define the initial stage of our project and thus physical design including the components, considering the different interactions with the environment and its reactions. Before any real technical inputs were made as regards to the design of the prototype, adequate level of research was first carried out. Sketches were made for different scenarios. During the research, we explored different methods that could enable our device to meet our targets, one of which was to work with sensors as input. Based on the dimensional restriction given for our device, we made the device compact by using similar components to show the simulation in the physical environment.

It contains three different parts as follow: Research, Hardware design, and Final Device.

***4.1 Research***

By the advance of modern design techniques, one must do the research behind it. We were given the challenge to create such sophisticated device that is autonomous and work with users demand without human interaction. For such requirements we had to

start from scratch by utilizing each component of the device and its function. The requirements given to us made us required working with advanced software like Microchip Studio. As we are aiming for a compact Design for our device, we studied some IoT designs. The design structure of such devices is complex but helped us understand the technology behind them. As we didn’t want to make a replica of such device, we analyzed the engineering behind it. More of our research went in search of unique components for the building the device. We didn’t have to suffer much to find the components as they were already given from our coordinators. But rendering all the elements required us to see if a simulation works in real world scenario. So, an online simulation on “Tinkercad” helped us realize the real-world simulation of our project. One of the most important parts of this projects to know the basics of a ‘Microcontroller’ and C programming which we had an idea from our previous and current semester.

***4.2 Hardware Design***

*Goal*

*Our goal was to design and construct an autonomous device which can detect moisture and light in real world.*

Our hardware design was comprised of various components including the Atmega128A, Button, Jumpers and wires, debugger, LED, Breadboard and a DC Motor, Moisture sensor and the light sensor. To achieve an efficient design, we tried to make the device compact by utilizing all the components accordingly. We did the research of finding unique components and design objects that will make our prototype different.

***4.3 Final Rendition***

For the final project work, our vehicle dimension was, we took the modern engineering principals to ensure quality and quantity.

To power the whole system and to obtain our goal certain elements were used in the project which are:

* Atmega128A Microcontroller
* DC Motors
* Bread board
* Wires
* Moisture sensor
* Light sensor

*Atmega128A Microcontroller:* ATmega128 is an AVR, 8-bit low power microcontroller that contains 64-pin interface and is based on RISC architecture. It is mainly used in an embedded system and industrial automation.

*Motor:* A DC motor (Direct Current motor) is the most common type of motor. DC motors normally have just two leads, one positive and one negative. If we connect these two leads directly to a battery, the motor will rotate. If we switch the leads, the motor will rotate in the opposite direction.

*Breadboard:* A breadboard is a solderless construction base used for developing an electronic circuit and wiring for projects with microcontroller boards like Arduino. As common as it seems, it may be daunting when first getting started with using on

*Wires*: The 24-gauge wire that is in CAT-5 cable kind of works but is thin enough that it will often come out when you are just moving the board around. 20-22 gauge is just about right and can handle any generic Arduino load that you put on it, as well as things like small DC motors, etc. that draw < 1.5A

*Moisture Sensor*: Moisture sensors measure or estimate the amount of water in the soil. These sensors can be stationary or portables such as handheld probes. Stationary sensors are placed at the predetermined locations and depths in the field, whereas portable moisture probes can measure soil moisture at several locations. We used this as a alternative to water sensor due to unavailability.

*Light sensor:* Light sensors are a type of photodetector (also called photosensors) that detect light. Different types of light sensors can be used to measure illuminance, respond to changes in the amount of light received, or convert light to electricity.

To maintain the precision of each element in its place in the device we did the measurements and after the production it was very much to assemble.

***4.4 Pin Setup***

Pins used for the Water assist pro,

Pin VIN – For voltage Input

Pin GND – For Ground connection

Pin PA0 – As Light switch

Pin PA1 – Connected to motor relay As Water Pump switch

Pin PF0 – For Moisture sensor

Pin PF1 – For Light sensor

***4.5 Source Code (Microchip Studio)***

The coding has been done by Using Microchip studio which gave us an opportunity to learn new software and its function. A sample code of the source is as follows:

#include <avr/io.h>

#define F\_CPU 800000000UL

#include <util/delay.h>

#include <stdlib.h>

#include <string.h>

void ADC\_Init(){

DDRF &=~(1 << 0); //ADC port as input

DDRF &=~(1 << 1);

ADCSRA = 0x87; //Enable ADC, fr/128 \*/

}

int ADC\_Read1(){

ADMUX = 0x40;/\* Vref: Avcc, ADC channel: 0 \*/

ADCSRA |= (1<<ADSC);/\* start conversion \*/

while ((ADCSRA &(1<<ADIF))==0);/\* monitor end of conversion interrupt flag \*/

ADCSRA |=(1<<ADIF);/\* set the ADIF bit of ADCSRA register \*/

return(ADCW);/\* return the ADCW \*/

}

int ADC\_Read2()

{

ADMUX = 0x41;/\* Vref: Avcc, ADC channel: 0 \*/

ADCSRA |= (1<<ADSC);/\* start conversion \*/

while ((ADCSRA &(1<<ADIF))==0);/\* monitor end of conversion interrupt flag \*/

ADCSRA |=(1<<ADIF);/\* set the ADIF bit of ADCSRA register \*/

return(ADCW);/\* return the ADCW \*/

}

int main(void){

int Moisture;

int LightSensor;

DDRA |= (1 << 0); //Output

DDRA |= (1 << 1);

ADC\_Init();/\* initialize the ADC \*/

while(1){

Moisture = ADC\_Read1();/\* Copy the ADC value \*/

LightSensor = ADC\_Read2();

if(LightSensor<900)

{

PORTA |= (1 << 0); //&=~(1 << 0);

}

else

{

PORTA &=~(1 << 0); //|= (1 << 0);

}

if(Moisture<900)

{

PORTA |= (1 << 1); //&=~(1 << 0);

}

else

{

PORTA &=~(1 << 1); //|= (1 << 0);

}

*\_delay\_ms*(50);

}

}

We have two main functions to work in our code. One is controlling light with light sensor and another on is controlling pump with Moisture sensor. So, we used light and moisture sensor as input with Port-F0 and Port-F1. Then Port-A0 for LED and Port-A1 for DC motor as pump. Both of our sensors give analog values. So, our main concern was to convert the analog signal values to digital. That's why we used the sensors with ADC ports. Through ADC conversion code we got a read to control our output devices. When programming the ADC to read multiple channels, only one channel can be used in the conversion at a time.

To switch between different analog inputs, we set the ADMUX register to point to ADC input. Analog input values ​​are usually read in via the AVR analog-to-digital converter (AD converter, ADC).

As soon as all the initialization, conversions are done, we wrote our control functions in the while loop using 'If-else'. One function is if light sensor value is less than 900, the LED will be High, else low. Another function is if moisture sensor does not detect water or it is also less than 900, the motor will be high. Otherwise, it will be low.

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